1.0 RENAISSANCE BACKGROUND 1

Section 2. Renaissance Prelaunch Operations 1

Section 3. RENAISSANCE Launch Countdown 1

Section 4. RENAISSANCE Launch Operations 1

Section 5. RENAISSANCE Early Orbit OPERATIONS 1

Acronyms and Abbreviations 1

RENAISSANCE OPERATIONS CONCEPT DOCUMENT (ACE)

(PRELIMINARY DRAFT)

8/3/94

1.0 RENAISSANCE BACKGROUND

1.1 Introduction

1.1.1 Overview

The Center of Excellence (COE) does the majority of work during the prelaunch period and hands over to the Project/Science Operations Center (SOC)

FOT will not try to get all data 90 percent over the mission lifetime. Ground system design will give high reliability.

Multiple support packages will be available to a Project at various price points.

1.1.2 Scope

TBS.

1.2 Mission Operations Division Center of Excellence

TBS.

1.3 Networks Center of Excellence

Requires assistance from Code 530.

1.4 Nascom Center of Excellence

Requires assistance from Code 540.

1.5 Flight Dynamics Facility Center of Excellence

1.5.1 Overview

Traditionally, GSFC-supplied spacecraft and launch vehicle orbit and attitude support to projects through the Flight Dynamics Division Code 550. To perform it's function, Flight Dynamics set up a support center from which all spacecraft and launch vehicles could be supported. Consequently, each flight project requiring Flight Dynamics services was considered a new entity. Specific requirements and interfaces would be negotiated on a mission by mission basis while concentrating on reusing applicable hardware, software, products, etc. previously developed for other missions. Experience has divided FDF into two sets of support functions:

orbit and attitude which has resulted in two operational support teams: FDF Orbit and FDF Attitude. Experience has also shown that in the majority of missions, a significant portion of attitude support can be performed separately from orbit support. This separation of function is especially true once a mission reaches the routine operations phase, but is not always the case.

To maximize success across a diverse set of missions, Renaissance proposes to move the mission specific functions performed by the FDF Attitude team into the MOC except for special support periods, such as: launch, early orbit maneuvers, etc., where the FDF Orbit and FDF Attitude teams require constant and immediate interactions and/or contingency/emergency situations that require a specific expertise. These periods, where maneuver support is better served by a centralized Flight Dynamics operation, will be supported by what Renaissance terms as the FDF COE. The FDF COE requires remote access to the MOC hardware/software environment as applicable.

1.5.2 Operational Profile

Pre-renaissance, the two FDF teams (FDF Orbit and FDF Attitude) were traditionally co-located in the Flight Dynamics area. Renaissance proposes as previously described, to move routine FDF functions to the MOC and keep non-routine functions in the FDF COE. The re-allocation of FDF functions affects the way operations will be performed. For example, where traditionally, the FDF Mission Manager (MM) coordinated the FDF Orbit and Attitude teams, in Renaissance, except for special support/contingency/emergency efforts, FDF functions transferred to the MOC will be under the direction of the MOM. Furthermore, coordination efforts between the FDF COE and the MOC will be complicated by distance. The following attempts to describes a conceptual operational profile for the FDF COE and transfer of FDF functions.

1.5.2.1 FDF COE Profile (Non-routine Operations)

The FDF COE will perform all FDF functions from the Phase A study through routine operations. Once the mission satellite is established in the appropriate orbit and routine operations have been established, the FDF COE will either provide a FDF analyst to the MOC, or provide training as necessary for a MOC analyst to perform the necessary FDF functions. If the FDF COE provides an analyst to the MOC it will be the same FDF analyst who has supported the mission during the entire support. This FDF analyst will become a member of the MOC and be cross trained to support the various flight control functions that the MOC requires.

The FDF COE will require non-routine access to the mission in order to provide on-demand support for a spacecraft. The on-demand support may include spacecraft emergencies, spacecraft anomalies, etc. In addition, it will be necessary for the FDF COE to have non-routine access to the mission data in order to perform various studies such as: attitude or sensor comparisons with other missions.

The Renaissance approach assumes that the FDF COE will be organized as is currently in place in the traditional Code 500 concept. As such, the following describes the functional organization of the FDF COE. The FDF COE is composed of a FDF Orbit team and a FDF Attitude team.

The FDF COE Orbit team is comprised of four small expert teams: Orbit Operations, Acquisition Data Operations (ADO), Metric Tracking Data Evaluation (MTDE), Orbit Maneuver planning, and several Mission Coordinators.

The Orbit Operations team's primary concern is Orbit determination, and the generation of EPHEMS.

The Acquisition Data Operations (ADO) team's primary concern is to generate acquisition data (ACQDATA) and planning predicts (pointing info) for DSN/GN from the EPHEMS. ACQDATA, which are high speed vectors, are sent to JPL.

The Metric Tracking Data Evaluation (MTDE) team's primary concern is to monitor the real-time tracking data for data quality and interface with the NOM to troubleshoot and resolve tracking data problems. Data quality information is passed to the Orbit Operations team. The MTDE team also performs Orbit determination which provides a secondary check for the orbit solutions obtained by the Orbit Operations team, however, rather than orbit, the MTDE team is more concerned with azimuth angles, elevation angles, etc. The MTDE's are used to support critical mission periods and not routine mission support. The Orbit Maneuver Planning team's primary concern is to generate the actual maneuver command set needed to perform an orbit maneuver.

The FDF Mission Coordinator's (MC) configure the necessary FDF systems before a support and handles communications traffic, as necessary, on the SCAMA loops. On the loops, FDF is known as FDF COMM.

The FDF COE Attitude team is comprised of: TBD

1.5.2.1 FDF COE Profile (Routine Operations)

The following describes the functions that will be capable of being transferred to the MOC.

TBD.

1.6 Information Processing Division COE

1.6.1 Level Zero Processing

Level Zero Processing Operations require the ACE Production Data Processor Subsystem (APDPS) and the ACE Real-time Output Subsystem (ARTOS) to provide RT data distribution, data quality assessment, quicklook product generation, level-zero product generation, and data distribution. LZP Operations also include maintenance of all ACE data storage systems.

1.6.2 Science Data Troubleshooting

Science Data Troubleshooting Operations require the Quality Analysis Workstation Subsystem (QAWS) to perform data analysis for data and system anomaly troubleshooting. The QAWS provides the capability to perform fault isolation of the end-to-end ground system, space to ground link and spacecraft. The ACE Science Troubleshooter will have the capability to detect problems in the quality, quantity, or processing of science data and isolate the source of an anomaly. The QAWS will allow for timely data recovery and ensure that mission data quotas are met.

1.7 Renaissance Operational Interfaces

ACE end-to-end mission operations involve, at a minimum, interfaces with the following: Spacecraft or Spacecraft simulator, Spacecraft vendor facility (for ACE APL), Delta launch vehicle simulator, DSN site, an RF link between the Spacecraft simulator and the DSN site (?), Eastern Range (including the LOCC and LOCC backup Facility), ground network, MOSA (Delta), MOC (including the Launch Support room, Mission Analysis Room, Mission Management Area), FDF COE (including the Vehicle Operations Room, the Payload Operations Room, and General Operations Room), SOC, NASA select (involving Tech Control), Voice Control, and institutional support such as hardware maintenance and software support.

ACE END-TO-END MISSION OPERATIONS SCENARIO

(PRELIMINARY DRAFT)

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Section 2. Renaissance Prelaunch Operations

2.1 Introduction

This section provides a high-level description of prelaunch mission activities performed to support end-to-end mission operations.

2.2 Background

A Mission begins by preparing a Phase A study. The Phase A study is provided by the Project to the appropriate 500 codes. Code 550 (FDF) uses the Phase A documentation to gather high level mission requirements. In addition, FDF has several discussions with the project about applicable sections of the Phase A study and generates a baseline launch trajectory analysis which includes burn times, burn duration's, launch windows, etc.

2.3 Mission Testing/Simulations

Mission testing starts approximately 1 year before launch. Numerous simulations are run to train the FOT, ensure the ground system is working properly, and prepare all mission support people for the actual mission. Scripts for testing spacecraft interfaces are created and by the ACE project and are coordinated by the S/C I & T Test Conductor. Scripts for testing the end-to-end ground system elements are created by the Mission Readiness Manager (MRM) and the Test Engineer (TE), approved by the Project, and coordinated by the MRM.

2.4 FDF COE Operations

2.4.1 Launch Minus 6 Months

Approximately 3 - 6 months before launch, FDF COE receives a DTO (Detailed Test Objective), which is an IBM 9 track tape from ER that defines the trajectory or trajectories of the launch vehicle with the payload attached. FDF COE uses the DTO tape to create tracking products such as predicted acquisition data and launch planning aids such as IIRV's (Improved Inter-range Vectors), IRV's (Inter-range Vectors), INP's (Internet predicts), planning products, etc. which are delivered to the MOC, NOM, DSN, and other support elements. The FDF COE planning aids are used by the Networks division to support NASCOM scheduling, DSN scheduling, etc. and by the various support elements involved in tracking the launch vehicle and payload. The FOT may use these products to determine timelines for operational procedures and simulation scripts. Periodically, as launch approaches, updated DTO tapes are made available to FDF COE.

The updated DTO tapes are processed and updated planning aids are sent to the various users for uses such as Launch Count development (created by the GNOM), antenna pointing products, etc.

2.4.2 Launch Minus 2 Weeks

At approximately L-2 weeks, the Flight Dynamics Facility (FDF) COE begins providing planning support products as required by all parties involved in the launch. The FDF COE Acquisition Data Operations (ADO) team provides premission Delta acquisition data (ACQDATA) to the appropriate ground stations for SECO support. The FDF COE Orbit operations team provides predicted long ephemeris to the ACE mission support team.

2.4.3 Launch Minus 1 Week

At approximately L-1 week, FDF COE ORBIT will provide a predicted long EPHEM (high speed vector) electronically to the MOC, SOC and CMF (Ethernet H/S vector to MOC also to SOC for some reason?). ADO provides premission C-Band radar ACQDATA to the appropriate ground stations , transmits updated nominal premission Delta ACQDATA for SECO and post separation support, and provides the JPL NOPE with pointing information (S/C ACQDATA - IIRV's, IRV's, or INPs). The ACQDATA via high-speed transmissions have traditionally transmitted as TTY messages or as TBD messages through the NCC. The FDF COE Flight Team Leader (FTL) provides a several week PSAT to the ACE mission support team for pass planning.

2.5 MOC OPERATIONS

2.5.1 Staffing

MOC staffing fluctuates over the end-to-end mission profile (pre-launch, launch & early orbit, spacecraft maneuvers, and routine operations). A staff up will start approximately 1 year before launch and full staffing will be "on call" by L-6 months. Staffing fluctuates depending on what type of training, testing, simulation, etc. are going on.

2.5.2 Databases

2.5.2.1 Database Descriptions

In Renaissance, the following databases will be provided for mission support:

a. PICS DB.

b. GTAS DB.

c. MOPPS DB.

d. FDF COE DB.

e. Telemetry and Command DB (T&C).

f. TPOCC System Variable DB (which includes T&C).

2.5.2.2 Database Operations

The FOT performs prelaunch database checks of the MOC mission software starting several weeks before launch and continuing periodically until just several days before launch. Traditionally, a validated T&C DB, referred to as the Project Database (PDB) is supplied (electronically? Tape? Floppy? Paper?) by the Project Integration and Test (I&T) section. The FOT is the administrator of the official T&C database. An ASCII version of the T&C DB is created, and the FOT has the responsibility to perform the database build and create the Operational Database (ODB). The ODB typically includes the T&C and TPOCC System Variable DBs. The FOT verifies that the ODB build without errors and places the database under configuration control. If the ODB build is successful, the MOM, who approves that the database is mission ready, is informed, and copies of the PDB and ODB are provided to the Program Maintenance Library (PML). A copy of the PDB is provided to CMS for their ODB generation. When CMS performs their build, since the FOT previously verified the database, no error checking is done for their build. If any other entity requires the T&C DB, it is the responsibility of the FOT to provide copies and updates.

The Project-supplied PDB is available to the FOT by L-TBD months. Frequent updates to early versions PDB are common and complicate database administration and configuration control for the FOT. The process of building, verifying, and distributing the ODB to users takes a considerable amount of the FOT's time. After a TBD period the database stabilizes, however, the database continues to be updated by the Project till L+30 days.

The T&C DB is built, checked, and distributed (as applicable) with every update. Copies are provided to the SOC and other users as applicable. The database has traditionally been copied to a tape and the tape sent to the SOC (or other user) though the USMail or other commercial carrier. If updates are required, the updates are sent as necessary. The frequency of database updates, number of users, distribution channels, and user training/checkout schedules complicate the database process for the FOT. For example, consider the complications generated by the necessity of a database build immediately before a major spacecraft checkout, joint simulation or training exercise.

It is the user's responsibility to run the software with the correct version of the database; however, the FOT is ultimately responsible because they provided the database and need to ensure a successful launch. Different database versions, across the various local and remote user systems, has been the cause of many weeks/days/hours of troubleshooting. Traditionally, the correctness of the database for all users has been determined through dataflows and simulations. Final MOC equipment and software configuration generally occurs several days before launch. A hardware and software freeze will also be imposed throughout GSFC and all other facilities involved in mission support at a TBD period before the launch.

2.5.3 LZP Operations

LZP Operations participate in the following:

a. Pre-launch testing.

a. End-to-end testing.

b. Supply science data to SOC for testing (on request and at L-1 year).

c. Create/test errored data.

2.6 Network Operations

2.6.1

As launch approaches (about 1 month), briefing messages are sent to ground system personnel, voice control (to have the operational SCAMA lines set up), appropriate DSN stations, DSN/GN stations that may be needed for backup or contingency operations, and any other mission support elements. The briefing messages have traditionally been the responsibility of the GSFC Networks Division and are handled by the GNOM.

2.6.2

The primary means for coordination between all the mission support elements and the MOC is though voice communication loops grouped by mission function. These coordination loops are called Secure Conferencing and Monitoring Arrangement (SCAMA) lines and for an ELV mission generally include the following loops:

a. Mission Ops is used for Real-time coordination between the FOT, Networks, FDF COE, and telemetry data recipients. (JPL Trackon)

b. Payload Net is used to coordinate final checkout, launch countdown, and readiness activities for the spacecraft.

c. Mission Management is used for coordination of go/no-go readiness and launch countdown activities with geographically diverse Project management personnel.

d. Primary Countdown is used by the Project Director to conduct launch vehicle activities per the launch script ad includes activities performed by spacecraft personnel.

e. Mission Coord is used by the Project Director to interface directly with the MOM and other GSFC management personnel.

f. Attitude Coord is used to provide a dedicated link for detailed Attitude Control Systems (ACS) conversations.

g. Engineering Support is used to coordinate/discuss engineering information from the spacecraft subsystem engineers and FOT.

h. Management Coord is used for TBS.

i. Science Coord is used for TBS.

j. TOC Coord is used for TBS.

k. TV Conference is used for TBS.

l. Track/Radar Coord is required by the FDF COE for TBS.

m. NOCC interface is used for TBS.

*if needed

Section 3. RENAISSANCE Launch Countdown

3.1 Introduction

This section describes the operations required during the launch phase (approximately L-48 hours) of a mission.

Days before the launch, launch support personnel will be moved to their designated locations and the manning of early operations positions will begin. The launch countdown starts several days before launch and system-wide support personnel begin 24 hour coverage. Support personnel start 24 hour coverage and as launch approaches, more and more mission operations support positions are staffed. Generally, peak mission staffing system-wide is reached 24 hours before launch.

3.2 Eastern Range Operations

3.2.1 Launch Director

The final go/no-go survey is performed at approximately T-10 minutes. This survey is performed by the Launch Director. The Launch Director poles the Launch Team (a select group of launch control managers) of which the Project Director is a member. The Project Director will survey his team right before he is asked by the Launch Director. The Launch Director will make final launch go/no-go decision based on his launch team's recommendations. If his survey results in a condition "green", then everyone is go for launch and the decision to go is announced on the appropriate SCAMA line. If not, then the launch is slipped and a determination of the problem is made. If possible, the launch count is picked up after the delay. Otherwise, the launch is canceled and the GNOM sends out an OPN with the launch status and immediate and future project plans.

3.2.2 Backup MOC

A complement of Project personnel are located at the launch site to provide assistance to the Launch Director and provide a backup capability to the MOC for contingency operations. The following personnel functions are usually located at the launch site: project manager, C&DH, power engineer, thermal engineer, communications, attitude, engineering instrument, science instrument, project system engineer, I&T engineer. These personnel require real-time interfacing capabilities with the MOC for the coordination of spacecraft operations.

3.3 Goddard Space Flight Center Operations

3.3.1 MOC Operations

3.3.1.1 Overview

The MOC will be located in the SOTA area at GSFC for launch. During the launch countdown phase the MOC consists of two cooperating support teams: the Project team and the MOT.

3.3.1.2 Project Team

The Project team is coordinated by the Project Director and consists of personnel representing C&DH, power, thermal, RF Engineering, attitude, engineering instrument, science instrument, I&T engineering, and the MOM. The Project team is responsible for the spacecraft and it's subsystems.

3.3.1.3 Mission Operations Team

The MOT is coordinated by the MOM and consists of the MOC Manager, Operations Engineer, RT Operations Supervisor, Spacecraft Analyst, command controller, Mission Planner, FDF attitude, and TBD LZP Analyst. The MOT is responsible for spacecraft commanding and spacecraft health and safety. In addition, the MOT maintains the ground system. During critical periods the following additional personnel will also be in the MOC for any activity deemed necessary by either the Project team or the MOT:

a. System administration.

b. Software system developers.

c. Hardware maintenance.

d. TLAN system engineer.

e. Various managers.

3.3.1.4 Flight Operations Team

The FOT performs various ground system checks to ensure that each support element is operational. In Renaissance, ground system checks will be performed by "pinging" the various support elements such as FDF COE, MOC,, DSN, etc.)

3.3.1.5 Operational Interfaces

All operational interfaces are checked several hours before launch. The FOT begins communications checks. Each person who interfaces with the MOC is called on the appropriate SCAMA. (Call signs for each operational interface/person have been previously established.) and is checked off on a list. The FOT has each site as appropriate flow data to the MOC and if successful, checks off each interface with a condition "green" status. Each party involved is surveyed and asked if their personnel and systems are ready for mission support by SCAMA voice requests. Once all status checks are made, the status survey is passed on to the MOM for a MOC mission readiness determination. If he is satisfied with the status results, he awaits a query from the Project Director who is generally located at the launch pad. As launch approaches, the MOC begins monitoring the spacecraft health and safety data, which is available until TBD before liftoff. This data was used to determine the status of the spacecraft for the launch readiness decisions. The spacecraft health and safety data from the launch pad ceases, so the FOT and other direct support teams monitor the launch pad video on monitors tuned to NASA select. The countdown continues and the FOT waits and listens to the last minute coordination efforts on the SCAMA's. Launch control is now in the hands of the Delta launch support team, directed by the Launch Director.

3.3.2 FDF COE Operations

FDF COE launch support begins approximately 24 hours before launch. Peak FDF COE staffing occurs 4 - 6 hours before launch. The DELTA ADO team will electronically transmit a ACE force model to the NCC and perform several DELTA theoretical trajectories to ensure solutions can be obtained. Computer Systems Management Support (CSMS) begins the configuration and checkout of the FDF COE systems. (Mainframes, workstations, faxes, etc.) The Mission Coordinator (MC) run data flows (e.g.. DRIMS, etc.) and perform voice checks as necessary. The Facilities Manager (FM) ensure that the Communications Front End (CFE) is configured and that all logging functions are ready. As launch approaches, The MC's attempt to obtain the tentative sat IDs required by the FDF COE systems by querying various people on the SCAMAs. There is generally some confusion as to who has this information, but after calling around on the loops, the information is obtained. Lastly, the FAX machine is set up to route incoming messages (like what?) to the NASCOM Communications Center (for some reason?).

ACE END-TO-END MISSION OPERATIONS SCENARIO

(PRELIMINARY DRAFT)

7/19/94

Section 4. RENAISSANCE Launch Operations

4.1 ER Launch Operations

At ER the launch team is in action monitoring the launch vehicle tracking data. ER processes the Delta launch vehicle telemetry data (320 kbps) which contains the RIFCA vector data and perform their own ranging. The Range Safety Officer has his fingers on the self destruct button in case of an anomaly. ER sends RIFCA vector data (16 kbps) from the Delta launch vehicle to GSFC in real-time. The RIFCA vector data is received by the MOSA where it is monitored for data quality by the GNOM and by FDF COE for processing to create planning products such as OPM's, IIRV's, and INP's. When "trajectory nominal" is announced on the SCAMAs, the launch team at ER is performing most of the operations to get the S/C into orbit. MECO , ignition of second stage, etc. are announced on the SCAMA's. The Ranging officer monitors launch in case a self destruct is required, etc.

4.2 FDF COE Launch Operations

The FDF COE processes the RIFCA vector data from the Delta ELV. The RIFCA data contains flight trajectory and attitude information from which planning aids are created for the launch support team. The FDF COE interfaces via a CCL line with the GNOM if they encounter data quality problems with the RIFCA vector data. The GNOM relays the FDF COE's concerns with the Range Control Officer at ER to troubleshoot the problem. It is FDF COE's responsibility to interface with the people who require the planning products that FDF COE generates from the RIFCA vector data.

As parking orbit insertion approaches, the FDF COE uses the RIFCA data to update their original calculations for S/C first contact predicts. If the discrepancies are out of tolerance, new predicts will be generated and new high speed vectors will be transmitted electronically to DSN for antenna pointing and spacecraft acquisition.

4.3 MOC Launch Operations

The MOC requires updated DSN spacecraft view predicts from FDF COE so that they are ready to initiate transmitter on commands as soon as possible. A runner is sent to FDF COE to get the predicts. Many times, the FDF COE analyst's complain that they are not receiving tracking data, consequently, FDF COE processing is delayed while the data problem is coordinated and researched by the GNOM. If FDF COE has not been able to obtain a solution, the runner will return to the MOC only to return several minutes later. The runner repeats this process until he returns with the predicts. It would be nice if this were electronic. The updates can be very frequent but for ACE will occur between 10 and 100 minutes after launch. The MOC team awaits first contact at the predicted time.

Section 5. RENAISSANCE Early Orbit OPERATIONS

5.1 First Contact (Pass 1)

5.1.1 Pass Support (Pass 1)

5.1.1.1 DSN/JPL

DSN begins an antenna sweep, looking for the S/C at the predicted time. DSN sweeps the S/C frequency by starting at the S/C center frequency and then adding and subtracting a variable tolerance to the center frequency and returning to the center frequency. Once back to the center frequency, DSN notifies the NOPE via a SCAMA that a two way lock has been established. The JPL NOPE notifies the FOT that they are "go for command".

If the spacecraft transmitter is turned on autonomously, then DSN attempts to find the designated carrier frequency. Otherwise, the MOC command controller is directed by the MOM to begin issuing "transmit on" commands and DSN monitors for the downlink frequency and s/c telemetry. If the transmitter frequency is not found, the command controller will continue sending "transmit on" commands for the duration of the first pass. Furthermore, DSN will begin increasing its transmitter's power and performing other techniques designed to find the S/C. If the S/C frequency is still not found, an extended launch support scenario will ensue. Various ground stations and NORAD will be requested for assistance and will attempt to locate the S/C.

If two way lock has been established by DSN, DSN will report to the JPL NOPE that they have locked on the carrier frequency. The JPL NOPE will notify the MOC via SCAMA.

5.1.1.2 MOC Operations

5.1.1.2.1 Nominal Operations Scenario

The following scenario describes nominal spacecraft operations in the MOC during the first pass:

The MOC command controller is directed by the MOM to begin issuing "transmit on" commands and DSN monitors for the downlink frequency and s/c telemetry. Simultaneously, FDF COE ORBIT is urgently requesting that the MOM provide them with tracking data ASAP in order for them to generate the EPHEM's the Project and DSN will be shortly demanding. The JPL NOPE reports on a SCAMA line that DSN has established two way lock on the spacecraft. For a brief moment, there is spontaneous applause in the MOC, then the MOC team goes into action.

ACE END-TO-END MISSION OPERATIONS SCENARIO

(PRELIMINARY DRAFT)

7/19/94

The command controller commands the spacecraft to begin sending telemetry. MOC displays come to life, data is detected. The S/C subsystem engineers do a quick look at their displays for any anomalies. The Project Director begins polling each of the subsystem engineers on the SCAMA's. "POWER report ... THERMAL report ... C&DH report ... RF report ... INSTRUMENTS report ... MECHANICAL report ...".

The spacecraft analyst begins monitoring the telemetry stream to ensure the commands were successful - Does the command counter show the correct number of transmitted commands? Are there any event messages? Out of limits conditions, etc. The command controller waits to start any contingency procedure mandated by the MOM as the spacecraft analyst quickly briefs him/her as to the command status and any problems that were detected.

On the Project side, the subsystem engineer/s responsible for the spacecraft mechanical interfaces monitors her display page/s to verify that the spacecraft structure survived launch - Is the Delta/spacecraft structure secure? Latches holding? Second stage mechanical interfaces nominal? Spacecraft deployable's nominal?

The subsystem engineer/s responsible for the spacecraft thermal systems monitors his display/s to verify S/C temperature and heater operations are within design parameters.

The subsystem engineer/s responsible for the spacecraft POWER systems monitors his display/s to verify that the solar arrays are functioning nominally, the shunts for dissipating excess power are working, the battery is charging, and operating as designed, relays operating, and the status of any other power supply electronics.

The subsystem engineer/s responsible for the spacecraft RF systems monitor her displays for RF system anomalies, link problems, and antenna problems. What is the spacecraft transmitter power level? What is the uplink power level being received? What are the DSN monitor blocks showing? Transmitter frequency? Lock? Is the spacecraft loosing lock? Why?

The subsystem engineer/s responsible for the spacecraft C&DH system monitors S/C system performance and throughput, verifies command execution, interpretation, and distribution, telemetry output, tape recorder health, stored command operations, spacecraft timing operations, etc.

The subsystem engineer/s responsible for the spacecraft Attitude verify that the spacecraft is oriented in the necessary attitude and that solar acquisition has been established. She also monitors to ensure that sensor performance is nominal. Other responsibilities include actuators performance, status of the control electronics, etc.

The subsystem engineer/s responsible for the spacecraft I&T

The subsystem engineer/s responsible for the spacecraft Instrument Science and Engineer - Verify instruments are in launch configuration (presumed to be off).

Other personnel are standing by to assist in any way possible (snapping page displays, logging specific event messages, assisting project personnel, updating status board(s), providing crowd control, etc.).

If the pass is nominal, the spacecraft is monitored and preliminary checks are made. If anomalies are detected, contingency procedures are started and RT re-planning is necessary.

5.1.1.2.2 Contingency Operations Scenario

The following scenario describes spacecraft operations typically encounter in response to anomalous conditions typical of problems encountered during the first pass:

The Command Controller commands the spacecraft to begin sending telemetry. MOC displays come to life, data is detected. The various S/C subsystem engineers do a quick look at their displays for any anomalies as described above in the nominal operations scenario. The Project Director begins polling each of the subsystem engineers on the SCAMA's. "POWER report ... THERMAL report ... C&DH report ... RF report ... INSTRUMENTS report ... MECHANICAL report ...".

During polling, POWER informs the Project Director that the batteries (battery?) is not charging and that the solar arrays are not producing the correct current levels and is convinced that power levels are too low to complete the entire pass as scheduled. He recommends that the transponder be powered off within two minutes or battery cell reversal is imminent. Attitude communicates that the control electronics were somehow powered off during the launch and that this has resulted in negative solar acquisition. She recommends that "Attitude Contingency Procedure #3" be run immediately. This solution is passed to the MOM who directs the Command Controller to begin the procedure immediately. The command controller begins the procedure while the operations engineer?? explains the problem to DSN (JPL NOPE???) over the SCAMA. Meanwhile, the Project Director has been discussing the problem with their launch personnel at the site in order to keep them apprised of the situation.

Upon completion of the contingency procedure, the telemetry verifies that the control electronics are powered on. The Spacecraft Analyst informs the MOM. The Project Director is also notified and a quick status verification is performed by both POWER and ATTITUDE. Due to the anomaly, power remains low. The Project Director directs the MOM to turn off the transmitter and terminate the support. The MOM directs the command controller to run the "transmitter off" procedure. The command controller does so, while simultaneously notifying the JPL NOPE that the support is being terminated. The transmitter is confirmed to be powered off by first noting the telemetry drop in the MOC, and then by verbal notification of LOS by the JPL NOPE. The first support is over.

5.1.2 Postpass Support (Pass 1)

5.1.2.1 LZP/ RT Trending

5.1.2.2 Contingency Planning Scenario

The first support is over. Assuming spacecraft anomalies were detected, contingency planning for the second support begins as follows:

The first step in contingency planning is to get a clear and complete status of the spacecraft configuration and the FOT immediately begins to gather data to be looked at. This may entail such things as snapping page displays, delogging event messages, history data processing and creation of X/Y plots.

The MOM, Project Director, subsystem engineers, operations engineer, mission planner and others who can assist in the problem gather in the Launch Support Room (or other conferencing area) to discuss the problem. Project personnel at the launch site are included via teleconference.

The first area of concern is to answer the question "why were the control electronics powered off?". It is concluded that either they were switched off during the launch assent due to vibration or else they were shut down due to some component failure. The real-time attitude determination showed that the spacecraft orientation was pretty stable (i.e.: it is not rapidly tumbling) and therefore some sunlight should fall on the solar arrays before the next pass. It is determined that the next support will need to be restricted to less than four minutes if the control electronics have flipped off again. A contingency plan is developed and STOL procedures are written to be executed in the event that the control electronics are in the off state. If the control electronics remain on, the spacecraft may still be maneuvering to acquire the sun, so it is agreed that no matter what, the pass duration will be limited to approximately four minutes. Even if the spacecraft has acquired the sun, it is predicted that the batteries will still only have reached about 75% state-of-charge and so a short pass should ensure that there sufficient power to resume the "early orbit plan" on the third support.

5.2 Spacecraft Checkout (Pass XXX)

5.2.1 Prepass Support

5.2.1.1 LZP Scheduling and Prepass Monitoring

At the beginning of each shift, the LZP operator reviews the schedule file through the GUI to verify that the LZP systems are correctly configured and scheduled to support the pass for each scheduled acquisition. The following are reviewed before each pass:

a. DSN Support Schedule + resource schedule (not true for 1 box PACOR) (schedule for spacecraft comm support for passes) to ensure that the correct ARTOS and APDPS are designated for use (don't forget the packet extractor)

b. Real-time Specifications to ensure the correct data are being forwarded to RT users

c. Product Specifications to ensure that the correct products are scheduled to be generated and delivered to the users.

If schedules do not exist or if a special request for support was received, the LZP operator will manually insert the necessary schedule information. To insert a support schedule, the LZP operator will require either electronic access to the support schedule with permission to update the LZP resources allocated for a pass support, or direct communications with the MOT personnel who have control over that scheduling. Verification of appropriate allocation of resources should come from the LZP operator.

To insert or update real-time specifications or product specifications, the LZP operator will access the specification entry windows through the GUI. Real-time specifications can be added or updated prior to or during a pass to: add or delete a RT data recipient, change the data being sent to a RT user (e.g., different APIDs, VC/APID pairs, etc.), or change the format of the Quality Accounting Capsules (QACs) being annotated to the RT data. To facilitate these changes, the LZP operator will require access to the RT support requests filed either manually or electronically with the MOT and a communications link with each RT data recipient. Product specifications, for both quicklook and level zero products, can be added or updated prior to a pass, during a pass, or after a pass, up until the session data is deleted from the on-line disks. A change to the product specifications may include: addition or deletion of a product user, creation of a special one-time only product to be distributed, changes to the contents of the product (APIDs, VCIDs, etc.), changes to the format of the product (ordering or grouping), and changes to the product annotation. To facilitate product specification creation, (Really SOC representative?) the LZP operator will require: access to user requests filed with the MOT and a communications link with each product recipient. For the most part, both RT and product specifications will be entered one time only, at the beginning of the mission support, since expectations of RT and production product formats are expected to be stable. The only additional specification entries will be as special requests for quicklooks or different processing, redistribution, etc. are received.

Prior to each pass, the LZP operator confirms that the socket connections have been received by the APDPS and ARTOS and that the ARTOS has connected with each RT user. Verification of this set up is done through the GUI.

5.2.1.2 Configuration Testing/Setup

The period of pass support begins with the monitoring of the internal Prepass Verification data flow, which provides a simulated data flow through the packet extraction phase, the applications services, and the LZP processors (See B. Connerton's data flows). The LZP operator will monitor the statistics generated. Would recommend that standard operating procedure for LZP systems involvement in this test would involve ARTOS connection to a RT User Simulator and APDPS to be set in capture only. Verification of success of the pass should include checking of appropriate packet and byte counts for each APID or VCID captured. The data would then be purged. During the test, the LZP operator will need to be in communication with the operations personnel running spacecraft communications and application services. Following support of that simulation, pass support moves to Prepass Readiness Test (PRT) data receipt and monitoring. The PRT data originates with the DSN site and is used to verify that the site to ground system link is established and supporting the required bandwidth. LZP system support of the PRT data should be limited to having the systems in capture only to ensure that data are being received and that byte counts approximate those received by Spacecraft Communications. During this test, the LZP operator should have a communications link with the MOT coordinator of communications with the DSN site.

5.2.2 Pass Support

5.2.2.1 MOC Operations

5.2.2.1.1 Tape Recorder Management Scenario

This scenario describes, at a high level, recorder management operations for a support during launch and early orbit.

5.2.2.1.1.1 One Recorder Operation

After AOS and establishment of good two-way lock with the spacecraft, the spacecraft analyst, Operations Engineer, and subsystem engineers will perform their initial health and safety checks of the spacecraft. The spacecraft analyst would initiate configuration monitors (which compare the telemetry to an expected state) to be checked by him/her and the Operations Engineer to ensure the spacecraft is still in an anticipated configuration. The subsystem engineers would perform their necessary checks of the telemetry to verify nominal operations of their subsystem. Upon hearing from the engineers that all the spacecraft subsystems are in a nominal state, and with no values having flagged in the configuration monitors, the spacecraft analyst makes the decision to begin the SSR playback.

At this time the command controller will send the command to switch the recorder function from the active SSR (which is to be played back) to the idle SSR. This will place the SSR which is to be played back into an idle mode while the other SSR begins to record data. This is an essential step in the process since the SSR lack the ability to concurrently playback and record.

After the command controller has determined through telemetry that the command was successful, he/she will notify JPL Track that the MOC is ready to begin playback of the SSR and inquire as to the status of the station to receive the VC2 data. JPL Track will then ask the station their status for the playback. The station will notify Track that they are "green and ready for the playback" JPL Track will then relay the message to the MOC. When the command controller hears from the JPL Track that the station is "green" and ready to receive playback data, he/she will then send the playback command while at the same time "marking" it for the station. The station should expect VC2 data momentarily after the "mark" command. The spacecraft analyst will verify the SSR is in playback mode via telemetry.

After the station has verified "lock" on VC2 data, it shall notify JPL Track who will in turn notify the MOC. The command controller will then check to ensure that VC2 data is being received at the MOC. Once the command controller has verified that VC2 data is being received in the MOC, he/she will notify JPL Track who will then relay the message to the station.

While the spacecraft analyst continues to monitor the health and safety of the spacecraft, the command controller will monitor the status of the playback to ensure the recovery of at least 90% of the data being played back by the SSR. This can be accomplished by using parameters such as the VC2 frame count, ground receipt time for the data, and the fact that ten VC2 frames are to be expected between each consecutive VC1 frame. The FOT will be able to monitor the playback status via the station through an internet connection established prior to the support. The station will provide the MOC the required parameters in real-time. The MOC will use these parameters to create a memory map of the SSR playback.

Knowing the size of the SSR and a VC2 frame, software can determine, by using the provided parameters, where precisely a data loss occurred. This memory map will mark off sections of the SSR memory whose playback data failed to be accounted for by the station. The software will also generate the commands to both recover and safe this data. At the conclusion of the playback, the spacecraft analyst will decide which of the two actions (if either) will be performed. This ability eliminates the book keeping work that would be required of the spacecraft analyst and command controller to determine which areas of the SSR needed to be played back in the event of data loss.

During the playback, the command controller and spacecraft analyst both notice a drop-out in the data. The command controller notifies JPL Track and asks for them to inquire as to whether the station still has lock with the spacecraft. About a minute later, the data begins to arrive at the

MOC again. Checking the memory map, the command controller determines that about 600 VC2 frames are unaccounted for at the station.

After the command controller has already determined the extent of the drop-out, JPL Track finally comes back and informs the MOC that the station had a failure of the auto-tracker for the antenna. Therefore, they lost lock and had to re-acquire the spacecraft.

Meanwhile, the spacecraft analyst checks to make sure that the required sets of commands were generated by the memory map software.

For the next half-hour, things are nominal. Suddenly, the command controller realizes that data has stop arriving at the MOC again. The command controller notifies JPL Track and has them ask the station if they are still locked on the spacecraft. JPL Track does so and informs the command controller that the station still has lock and is receiving data from spacecraft.

Instead of notifying the COMM Manager, the command controller next calls up an interactive display of the ground network. Starting with the MOC, he/she "pings" each node of the network searching for the missing data. Finally, it is discovered at JPL. It is all being buffered there because the router being used crashed and is unable to forward it. The command controller then informs JPL Track. Track informs JPL COMM, who then switches routers. The data again begins to arrive at the MOC. The command controller then realizes the MOC hardware is processing old data which had been buffered at JPL. Checking the data buffers in the MOC, the command controller realizes the data arrived in to large a quantity for the MOC hardware to process fast enough to catch up to real-time. Not concerned about old data, the command controller flushes the buffer so that real-time data will be processed.

During the remainder of the approximately 2.4 hour playback of the SSR, five more drop-outs occur for a variety of reasons. Much like the first drop-out, the memory map software has already created the safing commands as well as the playback commands.

Upon completion of the playback, the spacecraft analyst determines that enough time remains in the support to initiate recovery operations of the missing data. The command controller then notifies JPL Track to inform the station that the FOT will begin to try and recover as much of the missing data as possible during the remainder of the support.

Using the "random read" ability of the SSR, the command controller sends the command to playback the initial data lost during the playback. Once the data is accounted for at the station, the command controller sends the commands to playback the next block of missing data. This process is continued until the spacecraft analyst determines that not enough time remains in the support to playback another block of missing data.

At this time, the spacecraft analyst must decide whether to try and recover the missing data later, or ignore it. The criteria for the mission is 90% recovery of data per month. Taking into account the recovery rate of previous playbacks, the analyst decides to save the data and try to recover it later. The spacecraft analyst informs the command controller of their decision. Taking advantage of the "random write" ability of the SSR, the command controller sends the commands to "safe" the remaining blocks of missing data for future recovery.

Post-pass, the spacecraft analyst determines the time needed to recover the remaining data. It is determined, that ten minutes is all that is required to recover the remaining blocks of lost data. At this time, the command controller begins to look for another possible support to recover the data. Scanning the PSAT, the command controller determines that Madrid has a five hour view period starting in twenty minutes. The command controller then calls JPL Scheduling on the black phone to request that they try to schedule a twenty minute support with Madrid during the view period.

If Madrid is able to support a twenty minute pass, the data can be recovered. If no support can be scheduled prior to the next scheduled one, then the analyst can either ignore the missing data if they feel the monthly criteria will be met, or they can wait and try to recover it after the playback of the active SSR during the next support. This would require actively switching between SSRs to playback missing blocks of data in a ping pong fashion.

5.2.2.1.1.2 SSR Ping Pong Operation.

The following scenario describes how operations are complicated when playbacks are required from two recorders.

Upon completion of a playback, the MOT will send the commands to safe and recover missing data from the SSR just played back. Once all of that recorders data is recovered, the command controller will sent a command to switch data recording to the SSR which had just completed playing back its data. This makes the other SSR available for playback of missing data from the previous support. The command controller will send commands to start a playback of the now available SSR.

Once the data is recovered, the command controller will send a command to unsafe (thereby freeing up) that block of memory provided it had not already been skipped over while the SSR had been recording (safeties are only good for one skip). The record mode is then switched back to the proper SSR (the SSR that was not scheduled to playback data during the support). This SSR will then begin recording at the beginning, overwriting any data it recorded during the scheduled playback earlier in the support. This data and any data recorded by the other SSR during the support would have already come down in real-time. It is therefore not important to recover it.

The above scenario becomes more difficult if both SSR's have data to be recovered. Any data which is not recovered must have new commands sent up to safe that area of memory each time that block of memory is skipped during a record cycle.

5.2.2.1.2 LZP Operations

Level Zero Processing Operations are performed in conjunction with the following processing stages for each data flow: scheduling, pass monitoring, post-pass evaluation, product distribution, and data archival. In addition, the LZP operator is responsible for responding to special requests for redistribution and reprocessing of data. During each mission phase, pre-launch testing, launch, early orbit, and routine operations, the LZP operator performs essentially the same functions, as their support involves the processing of science data through the system to an end user, regardless of whether it is simulated, test, or spacecraft data. The functions performed for launch support are as follows:

a. Full operations to begin with first contact

b. Begin processing during OV or SV, depending on mission

c. Launch and Early Orbit phase includes increased percentage of quicklooks and rapid turnaround requirements.

d. Launch and Early Orbit may include increased percentage of data recovery required to facilitate SV.

5.2.2.1.2.2

Pass monitoring begins with the actual data flow from the source (DSN site, JPL, or internal simulator/replay). The LZP operator will monitor the statistics generated by the ARTOS and the APDPS during data capture, as well as monitor the data being transmitted to RT users. The GUI will automatically generate alarms and advisories in response to anomalies during processing, to which the LZP operator will respond on a case-by-case basis. If the transmission is anomaly-free, the pass supported will be essentially automated, with manual intervention required only to respond to requests for information from the other MOT elements, the DSN, or the RT users. Communications links with all of these organizations will be required. During contingency situations, the LZP operator may need to change the specifications for RT data, change the resource allocation for the pass (if permitted within the packet extraction design in SCComm), or report the anomaly and request a replay from JPL at the completion of the pass.

5.2.2.2 TBS

5.2.3 Post-pass Support

5.2.3.1 LZP Operations

5.2.3.1.1 Post-pass Evaluation

Upon completion of the pass, the LZP operator makes an initial assessment to identify major problems regarding quantity and/or quality of the science data, to allow rapid requests for redumps or replays. Assessment of the session quality is made against established criteria (a function which can be fully automated dependent upon the level of service provided to the user). Data accountability services are performed (quantity expected was received, again potential for automation based on characteristics of mission) by comparing the received statistics against known data characteristics and statistics from other MOT systems. Once assessment is complete, the operator enters in the assessment for the session via the GUI. The assessment assigned is the driver for the APDPS to include the data in quicklook or level zero products. During this phase, the LZP operator will require access to the statistics received from the DSN and those generated during packet extraction and nested processing. Access should be via the GUI, with communication available with other MOT members as required to pinpoint an anomaly. Following a passing session assessment, the APDPS will automatically begin generation of all quicklook and LZP products for which there is a product specification. The LZP operator will verify that product generation is progressing for each specified product and will review the statistics generated by the APDPS following completion of the product. The LZP operator performs an assessment based on these statistics and certifies the product as complete, entering this assessment into the system via the GUI.

5.2.3.1.2 Product Distribution

Once a passing product assessment is in the APDPS, the product distribution phase begins. The LZP operator verifies that the user has been notified that the product is available and monitors to determine when the user retrieves the products. Distribution of the products will be automated from the perspective of the LZP operator, and will require intervention only when a redistribution is requested. All monitoring of distribution is done via the GUI and the LZP operator will require a communications link with each product recipient as well as the network manager (in the event of transfer problems).

5.2.3.1.3 Data Archival

The LZP operator will support data archival of science products by monitoring transfer of the data to off-line storage, responding to requests for retrieval by loading data and accessing products, and managing any media as appropriate. As this functionality has yet to be defined, the following suppositions are made:

a. Determination of the schedule for transfer of data to off-line storage is made automatically.

b. Off-line storage will be disk storage or CD-ROM.

c. Manual intervention will be required only to enter requests for retrieval and to load media as appropriate; the system will automatically access the catalog and retrieve the appropriate products from storage.

The LZP operator will require access to the user requests for distribution of the archived data and a communications link with the product recipient. The LZP analyst will be able to perform all functions via the GUI.

5.2.3.1.4 Redistribution and Reprocessing

In response to requests for redistribution and reprocessing, the LZP operator will either manually initiate a recovery of a product from storage or manually request a replay of session data and enter a new product specification. In both cases, this function would be in response to user requests, with the operator entering in a specification to resend or reprocess and resend data. In some cases, replay of the data from through the front end would be required to achieve the reprocessing results desired by the user. The LZP operator will require a communications link with the product recipients and the MOT elements controlling internal replays (potentially the LZP operator as well - TBD) and requests for replays from JPL.

5.2.3.2 SCIENCE DATA TROUBLESHOOTING OPERATIONS

Science data troubleshooting operations are performed in response to a failure involving data processing arising in a degradation of data quality, a loss of data quantity, or a questionable system processing anomaly. The LZP operator is the first line in establishing the existence of a problem. The LZP operator will respond to a failure of a session or product to pass quality assessment by either releasing the data below criteria or holding it for further analysis. At a minimum, the operator would be required to decide whether to follow through on analysis of the problem. The ACE Science Troubleshooter would then take over to begin providing science data troubleshooting services.

The goal of the troubleshooting efforts is to determine if better quality or quantity data can be recovered for the science user and to pinpoint the cause of the anomaly to facilitate resolution. The troubleshooting operations revolve around the use of the QAWS to access the data at different points during processing and reconstruct the data processing flow until the source of the anomaly can be found and appropriate recovery actions taken. This level of service requires access to data before and after each processing step. The QAWS can hook into front end processing (frame synchronization, decoding, and packet extraction), real-time processing (packet or frame distribution in near real-time to user systems), and quicklook and level zero processing (data grouping, time ordering, redundant data deletion), provided the subsystems performing these tasks allow the access both in their hardware structure and their network connectivity. The QAWS is provided access on a non-interference basis to each of these data products as requested in response to an anomaly. To operate the QAWS system, the troubleshooter would recognize or have reported to them an anomaly, determine the course of analysis, and arrange capture of the appropriate data products on the QAWS. The arrangement could be either a test bed scenario where an analyst has a duplicate processing string available and the ability to receive replays of raw data, or just the QAWS with taps into the actual processing system. Either way, the use of QAWS functionality depends on having the architecture include the appropriate hooks.

Once analysis data sets are captured on the QAWS, the troubleshooter uses dump utilities to look at the data and its system annotations in order to pinpoint the cause of an anomaly and to determine the best course of recovery for: missing or degraded data, processing problems, or system failures.

To perform troubleshooting, access as many processing steps as the system design allows is required. In addition, the troubleshooter will require a communications link with each of the operational entities which control a tapped subsystem (front end, packet extractor, ARTOS, and APDPS). The troubleshooter will need to be able to order replays from JPL and internally for capture on the QAWS and to be able to perform these activities on a non-interference basis, with no contention for resources.

5.2.3.1.4.3 SCIENCE DATA PROCESSING SUPPORT OVER MISSION LIFETIME

Support from the LZP operator and the ACE troubleshooter will be required over the mission lifetime as follows:

a. Pre-Launch Testing

    1. Participation in End-to-End Testing

    2. Supplying science data to SOC for testing

    3. Errored data creation/testing

b. Launch Activities

    1. Full operations to begin with first contact

    2. Begin processing during OV or SV, depending on mission

3. Launch and Early Orbit phase includes increased percentage of quicklooks and rapid turnaround requirements.

4. Launch and Early Orbit may include increased percentage of data recovery required to facilitate SV.

c. Routine Operations: Support for each science data session (full operations) and in response to special requests from the data users.

d. Post-Mission: Response to requests for redistribution or reprocessing and redistribution of existing data sets.

5.2.3.2 TBS

5.3 Spacecraft Maneuver Operations (Pass YYY)

5.3.1 General

Maneuver operations involve two teams: FDF COE and the MOT. The following paragraphs describe how operations will be performed under the Renaissance approach.

5.3.2 Maneuver Planning

Maneuver planning requires interfacing with FDF ORBIT, FDF ATTITUDE, and the Mission Planner. The spacecraft predicts are compared to actuals to determine the extent of the re-plan. It is important to perform a maneuver as soon as it is feasible in order to minimize the amount of propellant (a consumable item) necessary. The longer the maneuver delay, the larger the trajectory error, and the more propellant it will take to correct the trajectory. Because of the propellant issue, FDF ORBIT is under pressure to have a good EPHEM available in the shortest amount of time possible, which then needs to be made available to the FDF Orbit Maneuver Planning team and the MOC. Moreover, the reason why the predicts are off must be established and that information made available to the attitude engineer in the MOC, If the reasons had to do with launch vibration the various FDF programs must be updated, if they are distributed, someone must ensure versions are the same. Otherwise errors.

5.3.3 Maneuver Planning Scenario

The following is a mission planning scenario for launch and early orbit.

As the ACE spacecraft approaches the L1 node, the project determines it is time to plan for the Halo insertion maneuver. This maneuver will place ACE in a circular orbit about the L1 node. The MOC and FDF are notified about three weeks prior to the event.

ACE END-TO-END MISSION OPERATIONS SCENARIO

(PRELIMINARY DRAFT)

7/19/94

The FDF COE provides the MOC mission planner with the initial prediction for when this maneuver will take place. The mission planner then checks the strawman schedule received from JPL to verify whether a support already has been scheduled that spans this time. None has been, so the mission planner submits an add request for a support that envelopes the initial predicted time for the maneuver.

While JPL scheduling handles the request, the mission planner begins to interact with the FDF COE and MOC FDF attitude person to plan how to handle the maneuver. They must decide what commands to issue out of memory and which to issue in real-time.

The MOC mission planner receives the forecast schedule two weeks prior to the event. The requested support times have been granted. The mission planner contacts the FDF COE to notify them and to ensure the times are still accurate.

The FDF COE informs the MOC mission planner that the initial time was off about five minutes and will probably drift some more as the event approaches and the orbit models they use become more accurate. The MOC mission planner notes this and submits a request to the JPL to slide the support time back a half hour to account for any additional drifts in the maneuver start time.

JPL scheduling receives the input and obliges, even though it impacts another mission. ACE has a higher priority due to its LE&O status.

A week prior to the support week, the MOC mission planner receives the confirmation schedule from JPL. The support is shown with the correct times. All that remains is the building of the loads to handle the commands FDF COE wants executed out of memory prior to the maneuver.

The MOC mission planner contacts the FDF COE to obtain the initial commands to be executed. The load is built with these commands two to three days prior to uplinking.

As the event approaches, the FDF COE will provide the MOC mission planner with any changes that may occur due to newer tracking data.

One day prior to the uplinking of the memory load, the FDF sends their final version of the commands to the MOC mission planner. These changes are added to the load. The load is then checked and verified by the FDF COE, observatory engineer, and the mission planner.

Once verified, the load is sent to the proper directory to await uplinking to ACE. The MOC mission planner then generates the pass plan detailing the commanding and operations to be performed during the support, and the ground script to configure the MOC for the pass.

The load is uplinked the support prior to the maneuver. The MOC mission planner has completed their role in the maneuver.

5.3.4 Maneuver - MCC1

5.3.4.1 Prelaunch/Prepass

During the prelaunch/prepass period, FDF calculates the predicted launch trajectory. FOT verifies that systems are ready. FFAE verifies that command loads are ready and correct, and briefs the spacecraft analyst command controller and supervisor.

5.3.4.2 Launch/Prepass

During the launch/prepass period, FDF monitors the actual trajectory based on delta telemetry, calculates updated spacecraft orbital predictions, and compares the predictions to the actual orbital data.

5.3.4.3 Pass

During the pass period, FFAE monitors spacecraft attitude (attitude and spin rate) during orbit maneuvers; monitors thruster valve status, tank temperatures, and pressures; and determines the spacecraft spin rate based on spacecraft telemetry. FDF Orbit monitors spacecraft telemetry for some purpose TBS.

5.3.4.4 Postpass

During the postpass period, FDF performs the following:

a. Obtains the last known orbit from delta telemetry.

b. Determines if an insertion-error-correcting orbit maneuver is needed. If a correction maneuver is required, the following are taken:

    1. FFAE talks to an orbit person

    2. Determine time of (orbit?) maneuver (who determines this?)

    3. Talk to mission planner to see what FOT has going on and why? See if a pass can be Scheduled at the time wanted.

    4. Mission planner needs to talk to SOC to see if any interference with SOC plans

    5. Mission planner checks RUST schedule for possible supports.

    6. If problem, tells FDF Analyst who relays to FDF Orbit.

    7. Possibly talk to Operations Engineer about maneuver (for some reason?).

8. FDF Orbit negotiates original time/picks another time. Continue until maneuver time is agreed on.
9. FFAE talks to FDF ORBIT and determines delta-V direction chosen for axial burn time and desired spin rate.
10. FFAE gets last known propulsion system temperatures & pressures.
11. FFAE determines if a spin maneuver is needed for the maneuver.
12. FFAE plans for a maneuver.
13. FFAE checks with mission planner to determine appropriate time for spin maneuver.
14. Mission planner checks with SOC and Operations Engineer.
15. Spin maneuver time planning continues until agreed on.
16. Spin maneuver planned to have no effect on attitude or orbit.
17. FFAE generates commands using GMAN and gives them to the mission planner(?), makes available to command database? (who gets them and how?)

SECTION 6. Renaissance Routine Operations

6.1 General

TBD.

6.2 Prepass

TBD.

6.3 Pass

6.3.1 Nominal Tape Recorder Management

After AOS and establishment of good two-way lock with the spacecraft, the spacecraft analyst will perform their initial health and safety checks of the spacecraft. The spacecraft analyst would initiate configuration monitors (which compare the telemetry to an expected state) to be checked by him/her to ensure the spacecraft is still in an anticipated configuration. Upon determining that the spacecraft is in its nominal configuration, the spacecraft analyst makes the decision to begin the SSR playback. At this time the command controller will send the command to switch the recorder function from the active SSR (which is to be played back) to the idle SSR. This will place the SSR which is to be played back into an idle mode while the other SSR begins to record data.

6.3.2 JPL/DSN Coordination

Once the command controller has determined through telemetry that the command was successful, s/he will notify JPL Track that the MOC is ready to begin a playback of the idle SSR and inquire as to the status of the designated station for the VC2 playback. JPL Track then queries the station as to their status for the playback. The station will notify JPL Track when they are "green and ready for the playback" and JPL Track will relay the message back to the MOC. When the command controller receives a "green" and ready status from JPL TRACK, s/he will send the playback command and coordinate the event with JPL Track by simultaneously announcing "mark" on the loop. The station should expect VC2 data momentarily after "mark" is heard. The spacecraft analyst will verify the SSR is in playback mode from the telemetry.

Once the station obtains "lock" on the VC2 data, JPL Track will be notified. JPL Track will then relay the status back to the MOC. The command controller will then check to ensure that VC2 data is being received at the MOC. Once the command controller has verified that VC2 data is being received in the MOC, s/he will notify JPL Track who will relay the message to the station.

6.3.3 DSN Playback Statistics

While the spacecraft analyst continues to monitor the health and safety of the spacecraft, the command controller will monitor the status of the playback to ensure the recovery of at least 90% of the data being played back by the SSR. The FOT will monitor the playback status at the station through a remote access connection established prior to the support. The station statistics will provide VC2 frame count's and other relevant information to the MOC in real-time. The MOC will use the station playback statistics to create a memory map of the SSR playback which will be used to support data recovery/tape recorder management if necessary.

6.3.4 Data Capture/Recorder Management Operational Criteria

The playback is completed approximately 2.4 hours after it began. The spacecraft analyst determines that a little more than 98% of the data was accounted for at the station. Since the established 90% data capture requirement, previously agreed to by the Project, has been met, s/he decides it is not necessary to recover the missing data. Instead the spacecraft analyst decides to recover some of the missing data from the previous day's support .

Carrying out the spacecraft analyst's decision, the command controller informs JPL Track that the MOC plans to dump portions of the spacecraft SSR. JPL Track informs the station. The command controller sends a command to switch recording to the SSR which was just dumped. Upon verification telemetry that the DDS switch was successful, the command controller sends the commands necessary to playback the desired memory locations from the SSR. Once the command controller verifies receipt of this data, s/he initiates commands to unsafe those portions of DDS memory just played back. The SSR is now available to record new data. Lastly, the command controller commands the S/C to switch recording back to SSR-1.

The spacecraft analyst, satisfied with the percentages of data recovered from both SSRs, decides to terminate all SSR operations for this support. For the remainder of the support, the spacecraft analyst monitors the health and safety of the spacecraft.

6.4 Postpass

6.4.1 Mission Planning

The following describes at a high level the mission planning task and the interfaces required to perform it. Mission planning starts about three week prior to the intended support.

Mission planning includes: network scheduling, spacecraft and ground resource scheduling, contact planning and scheduling, and the generation of planning products, ground scripts, pass plans, and spacecraft loads. The person responsible for coordinating and accomplishing these tasks is the MOT Mission Planner.

To perform mission planning , the mission planner must have access to planning and scheduling information from the Deep Space Network (DSN), ACE Science Operations Center (ASOC), FDF COE, and MOT FDF Attitude Engineer. In addition, mission planning requires access to information concerning command and telemetry definitions from the PDB and the spacecraft s/w image map showing the current version and status of onboard s/w. The following discusses each of these interfaces and their contributions to the mission planning task.

6.4.2 DSN Interface

The DSN provides the mission with its primary means of communication with the spacecraft. It is the scheduling of their antennas and ground systems which are the main focus of the mission planner. The DSN is managed by the Jet Propulsion Laboratory (JPL) and is comprised of three stations: Canberra, Goldstone, and Madrid. It is through JPL that the mission planner must interface in the scheduling process.

The process begins for JPL when it receives from the FDF COE preliminary satellite acquisition tables (PSATs) for a mission. These tables show when a satellite will be within view of a ground station. Using these predicts, a spacecraft priority system, and the generic requirements for each mission supported, JPL Scheduling will generate schedules on a weekly basis. These schedules will come in three forms: strawman, forecast, and confirmation.

6.4.2.1 Schedule Generation

The scheduling period will cover Monday to Sunday (UTC). The strawman schedule will be provided 17 days prior to the first activity in its scheduled week, and it will include the JPL composite schedule of orbiting spacecraft support and the missions DSN schedule. The forecast schedule will be provided 10 days prior to the first activity in its scheduled week. The confirmation schedule will be provided 3 days prior to the first activity in its scheduled week. The confirmation schedule will show the composite schedule and it will give a mission only schedule. All schedules will normally be made available on Friday (0000 UTC).

The key difference between the strawman, forecast, and confirmation schedules is that the strawman and forecast schedules may not be conflict free; however, the confirmation schedule is conflict free. Conflicts are flagged on the strawman and forecast schedules that are made available to the mission.

An activity will not appear on the confirmation schedule unless all required resources are predicted to be available at the scheduled time. The confirmation schedule commits all required resources from the start of activity (SOA) to the end of the activity (EOA). If certain resources are required for only a portion of this period, a manual override allows the operator to schedule two activities that can timeshare resources.

6.4.2.1.1 Changing a Strawman or Forecast Schedule

Following the receipt of the strawman or forecast schedules, a mission may request changes to these schedules by adding or deleting activities. Requests for changes may be made at any time between the receipt of the strawman or forecast schedule and Tuesday at 2000 UTC of the following week (i.e., before the next forecast or the confirmation schedule generation). The mission may request the following changes to the forecast: insertion of a new schedule activity, and the deletion of an existing schedule activity. The mission electronically submits these add/delete requests to JPL using the RUST. If the add/delete requests are accepted, JPL will respond to the changes and the results will be reflected in a subsequent confirmation schedule. Multiple changes specified within a single request are treated as a unit.

6.4.2.1.2 Changing a Confirmation Schedule

All changes to the confirmation schedule are considered as contingency changes. The mission may electronically request additions or deletions after the confirmation schedule is received. Up until 2 hours before an activity, an accepted addition or deletion will be updated on the latest confirmation schedule. JPL may also accept add and delete requests less than 2 hours before the activity; however, JPL Scheduling will verbally notify the affected missions and will then send the updated schedule.

A voice/electronic interface is used for handling schedule change requests that occur more than 24 hours before the affected pass. This transaction is initiated by the mission via the RUST and is confirmed by voice communication. The mission electronically sends a schedule add/delete request to JPL. JPL personnel examine the request and respond, either electronically or by voice communication, yes/no, or they can defer the transaction to a later time. When a request is approved, JPL regenerates a confirmation schedule within 2 hours and makes it available to the mission. It will show the remaining scheduled events of the week.

A voice interface is used for handling change requests occurring less than 24 hours before the affected pass. This transaction is initiated by the mission and is maintained by voice communication. The mission requests, via voice communications, modifications to the confirmation schedule. JPL personnel respond (yes/no) within 1 hour and relay schedule changes to the affected parties.

6.4.2.2 JPL/Mission Planning Transactions

There are three classes of transactions which may take place between JPL and the mission planner during a planning phase. They are as follows:

a. Scheduling add and delete requests - the mission may request a modification to a schedule. JPL can respond to each request by either accepting it, rejecting it, or deferring the request for schedule changes that require additional network resources. For schedule changes that do not require additional network resources, such as schedule deletions and minor changes to pre-pass and post-pass times, JPL will accept the requests.

b. Retransmission requests - These messages involve requesting retransmission of data which has previously been transmitted to the mission.

c. Administrative messages - These messages involve indirect support of scheduling activity and maintenance of the electronic interface.

6.4.2.2.1 Administrative Messages

The scheduling interface supports the exchange of free-form test messages between the JPL and the MOT. The messages are restricted to passing supplementary scheduling information not included in currently defined standard messages. Either JPL or the MOT can initiate administrative or test message transmissions.

6.4.2.2.2 Strawman Availability

The strawman schedule covers a 7-day period from Monday through Sunday and is placed in the mailbox 17 days before the start of the period covered

6.4.2.2.3 Forecast Availability

The forecast covers a 7-day period from Monday through Sunday and is placed in the mail box 10 days before the start of the period covered.

6.4.2.2.4 Confirmation Schedule Availability

JPL places confirmation schedules in the mailbox weekly or when a schedule is changed. The conflict-free schedule covers a 7-day period from Monday (0000 UTC) through Sunday (2359 UTC) and is made available on the Friday (0000 UTC) before the start of the period covered (i.e., 3 days before). Scheduled passes which cross over the change of day are reported on the day initiated and are considered as a single activity. If changes occur in the schedule, JPL places the updated schedule in the mailbox. JPL maintains confirmation schedules covering the current week. After Friday (0000 UTC), JPL also maintains a confirmation schedule covering the following week.

6.4.2.2.5 Changes to the Mission Scheduling Requirements

Generic scheduling requirements can be created, deleted, or changed at the request of the project. There is a paper interface between JPL and the project, but voice communication may be necessary to negotiate the request. Project personnel will mark up a paper copy of the Mission Scheduling Requirements memo and send it to JPL. JPL evaluates the request and if accepted forwards the new Mission Scheduling Requirements memo to the MOT mission planner. If the request is rejected, a written explanation is sent to the project.

6.4.2.2.6 Schedule Requests Before Schedule Generation

The MOT can request an addition or deletion to a schedule in the strawman or forecast time period via the electronic interface. Early specific requests may be submitted up to 11 weeks in advance. All viable requests are accepted and entered into the JPL scheduling data base. These schedule change requests are rejected only if they contain errors. No response is sent to MOT unless the request is rejected because of errors. The MOT mission planner creates and electronically transmits a schedule add request that specifies the nominal SOE. Request errors are handled through verbal communication initiated by JPL.

6.4.2.3 Spacecraft Emergency

When spacecraft emergencies occur involving a mission, the MOT will contact JPL and give verbal instructions regarding the types of emergency support required. Emergencies involving health or safety of the mission will have precedence over all routine support at JPL and the DSN.

6.4.3 ASOC Interface

The ASOC is the entity responsible for the science operations of a mission. A single spacecraft may provide a platform for a variety of instruments. Each of these instruments most likely will be under the control of a different principal investigator. It is the Sacs task to coordinate and schedule science operations between these principal investigators and then provide the MOT mission planner with their instrument commanding requests.

6.4.3.1 ACS Scheduling Interactions

The planning for a science operation begins 17 days prior to the support week when the ASOC sends to the MOC its instrument commanding requests. Depending on the spacecraft, this request may involve simply issuing instrument control commands at a certain time, to performing maneuvers to position the instrument in the proper orientation to accomplish its task.

Once the MOT mission planner has received these requests, they must determine what resources are required to grant them. Again, depending on the spacecraft and specific request from the ASOC, the MOT mission planner may also have to plan a spacecraft maneuver to meet the request. This would involve interacting with the FDF COE and MOT FDF Attitude Engineer. (This interaction will be discussed later.) At the least, it will require the issuing of spacecraft commands to onboard subsystems and not just the instruments. The MOT mission planner must also consider other routine as well as health and safety related operations required by the MOT and plan around them.

Coordinating all of these factors, the MOT mission planner will schedule the ASOC instrument requests and then transmit this schedule to the ASOC 10 days prior to the support week.

The next eight days will involve the MOT and ASOC negotiating over the instrument command schedule. Two days prior to the support week, all planned spacecraft activity is finalized and the schedule is locked barring any unforeseen events

6.4.4 FDF COE Interface

The FDF COE is responsible for performing computational activities that generate spacecraft acquisition data, tracking data, and orbit data to meet the needs of a mission. The FDF COE will also provide the MOT with assistance in planning spacecraft maneuvers.

6.4.4.1 FDF COE Scheduling Interactions

The FDF COE's involvement with the scheduling process is to primarily provide products to aide in the scheduling of real-time contacts and onboard events. These products include the PSAT, which shows when a spacecraft will be in view of a station, eclipse predicts, times for entrance and exit of bands (i.e. SAA, ZOE, RFI zones, etc.), and ephemeris predicts.

The actual process begins when the FDF COE puts out their three week planning predicts. These predicts are received at both the MOC and JPL and are used in the initial planning for the support week covered. The initial result of these predicts is the generation of the strawman by JPL.

The MOT mission planner will use these predicts when they receive the strawman and shortly there after the initial ASOC instrument command requests. The MOT mission planner will first use the predicts to determine which supports listed on the strawman are acceptable and which are not. They will then use them to find additional or replacement supports for the supports they wish to delete.

Next, the MOT mission will use the predicts to schedule onboard science operations in response to the ASOC requests. The execution time of the ASOC requests will be dependent on the location of the spacecraft and it will be the MOT mission planners job ensure that this execution occurs at the proper time.

It should be noted that the initial predicts are generated three weeks prior to the supported week. As the scheduling process approaches the support week, FDF COE is able to provide more accurate predicts to the MOT. Upon receipt of each set of new predicts, the MOT mission planner must update all planned activities to reflect any changes from the last set of predicts.

6.4.4.2 Spacecraft Maneuver Scheduling

The FDF COE provides an important service to the MOT by supporting spacecraft maneuver operations. Whether the maneuver is an orbit insertion or just a pointing operation, the FDF COE will provide the MOT with the proper commands and times to execute them.

Maneuver planning, like all other planning, begins 17 days prior to the event. The MOT mission planner will either be informed by the project to plan a maneuver, or they will identify that one is needed in response to a ASOC request.

The MOT mission planner will inform the FDF COE, which will then begin detailed planning for the maneuver. The MOT mission planner will meanwhile plan operations around the event.

The entire time leading up to the maneuver, the MOT mission planner and FDF COE are in contact daily to make adjustments as the predicts become more accurate. The details will not be finalized until less than 24 hours prior to the event.

6.4.5 MOT FDF Attitude

The MOT FDF attitude person will reside in the MOC. Their task is to provide near R/T attitude determination for the mission. During LE&O, maneuvers, and anomalies, this person will have access to the FDF COE for planning and investigation purposes.

The MOT FDF attitude person will interact with the MOT mission planner by providing spacecraft attitude solutions for help in planning onboard science and subsystem operations.

6.4.5.1 MOT FDF Attitude Scheduling Interface

This process again begins 17 days prior to an event when the MOT mission planner begins to schedule operations for the support week covered by the strawman schedule. Once the mission planner has identified the tasks which will require attitude adjustments onboard the spacecraft (i.e. targeting of an instrument), they will notify the MOT FDF attitude person. This person will then begin to coordinate the actions necessary to transition the spacecraft attitude from one scheduled task to another.

This coordination will be dynamic since the attitude of a spacecraft may be in a constant state of change. However, as the support week draws closer, a more definitive attitude solution can be derived. The MOT FDF attitude person will finally freeze their iterations and provide the MOT mission planner with the necessary commands to properly position the spacecraft for each planned activity. These commands will be provided two days prior to an event day to allow the mission planner to enter the commands into the command load which will be uplinked to the spacecraft.

6.4.6 Mission Planning Scenario

The following is a brief scenario showing the mission planning task during normal operations.

The planning process during normal operations begins three weeks prior to a support week when JPL and the mission planner receive from the FDF COE the three week planning predicts. The MOC mission planner now must wait for JPL to generate the DSN strawman schedule from the predicts.

The MOC mission planner receives the strawman, via the RUST, seventeen days prior to the support week and awaits the commanding requests from the ASOC, who also received the strawman for their planning purposes.

Upon receiving the ASOC commanding requests, the MOC mission planner checks to ensure that the supports scheduled on the strawman will be sufficient to handle the requests from the ASOC as well as routine health and safety operations by the MOT. At the present time, it appears to be sufficient.

About two weeks prior to the support week, the MOC mission planner uses the RUST to obtain the DSN forecast schedule. The MOC mission planner also receives from the FDF COE the most current predicts for the support week.

Using the predicts and the ASOC commanding requests, the MOC mission planner schedules the instrument operations and updates the execution times to reflect the most current FDF predicts. The mission planner then sends this schedule to the ASOC for their approval.

While awaiting the ASOC response to the schedule, the MOC mission planner begins the scheduling process for the next support week. Using the RUST, the MOC mission planner obtains the strawman corresponding to the next support week and checks to see if the forecast schedule for the support week currently being scheduled has been changed. The MOC mission planner notices a new version of the forecast schedule has been generated. Upon further examination, the MOC mission planner learns that a support has been deleted. The MOC mission planner decides to send an electronic message to JPL inquiring as to why it was deleted and requesting another support be scheduled in its place.

Now waiting for the response from the ASOC and JPL, the MOC mission planner is informed by the observatory engineer to plan for magnetometer calibration operations during the next support week. The MOC mission planner is informed that this operation can be performed in about fifteen minutes, but no science data can be collected during that time. The MOC mission planner decides to schedule the calibration during a regularly scheduled support.

Checking the schedule, the mission planner decides to reschedule an ASOC request to allow the calibration operation. The MOC mission planner contacts the ASOC and informs them of the move and the deleted pass. The ASOC responds by telling the mission planner that the target of opportunity will not exist at a future data and would like to have the calibration replace another scheduled science operation which could be performed at another time. As for the deleted pass, it has no impact as long as the instrument commands are executed out of the daily load. The mission planner informs ASOC that they will check with the observatory engineer to see if the calibration can be performed during the alternate time.

The MOC mission planner learns from the observatory engineer that the calibration can be performed during the alternate time suggested by the ASOC. The MOC mission planner informs the ASOC.

Three days prior to the support week the MOC mission planner receives the confirmation schedule via the RUST. They check to see if a replacement support has been scheduled. It was for a later time that day with a different station. They also learn from an electronic message that the reason it was deleted was the station originally scheduled was needed to support another launch activity.

With all conflicts resolved, the MOC mission planner generates the first load for the support week. Along with the load, they generate the ground script and pass plan. These products are all sent to their required destinations to await their uplinking or execution.

The MOC mission planner now focuses on the next support week.

6.4.2 Trend Analysis

The following scenario briefly describes data analysis and performance trending to be performed by the FOT following a support:

Upon LOS and completion of post-pass tasks, the command controller will ensure that all expected VC2 data resides in the MOC. The command controller will then perform LZP of the data. When LZP has completed, the command controller will issue a STOL directive to copy the LZP data to the string on which GTAS resides and a central account from which the system administrator can archive it.

On an off-line string where GTAS resides, the command controller now precedes to bring up the mission software. He/she then initializes the system and opens predefined subset files. These subset files will "pull out" and save values for selected mnemonics as a data is played back.

Next, the command controller begins this playback by issuing a STOL directive to acquire onto data.

When the playback is completed, the command controller closes out the subset files, and issues a command which begins GTAS. This command specifies a predefined file to be accessed by GTAS with the constraints needed for execution (i.e. information on what plots to create, time span to be used, etc.). The command controller has completed his/her task and is now free to work on another.

Finally, when GTAS has completed its operations, the command controller returns to collect the generate plots and reports which show anomalous activity during the period spanned by the data. If none are generated, then no anomalous situations occurred according to GTAS and its expected profiles for the data. In either case, GTAS will store all reports (i.e. plots, RTE's, MMM's, etc.) in an electronic form for recall and archiving purposes.

In this instance nothing is generated to show an anomalous situation. However, if one had occurred, the command controller would have presented the information to the observatory engineer. If he/she could not explain the anomaly, then they would begin an investigation by having the spacecraft analyst obtain information on previous history using GTAS and archived data from earlier supports.

Acronyms and Abbreviations

Term	Definition
ACE	Advanced Composition Explorer
ACQDATA	acquisition data
ACS	Attitude Control System
ADO	acquisition data system
AOS	acquisition of signal
C&DH	command and data handling
CCL	closed configuration loop
CFE	communications front end
CMF	Command Management Facility
CMS	Command Management System
CSMS	computer systems management support
DB	data base
DRIMS	
DSN	Deep Space Network
DTO	detailed test objective
ELV	expendable launch vehicle
ER	Eastern Range
Ethernet	
FDF	Flight Dynamics Facility
FOT	Flight Operations Team
FTL	FDF Flight Team Leader
GN	ground network
GNOM	

GTAS	
H/S	health and safety
I&T	integration and testing
IGSE	instrument ground support equipment
IIRV	improved interrange vector
INP	Internet prediction
IP	
IRV	interrange vector
JPL	Jet Propulsion Laboratory
JPL TRACKON	
kb/sec	kilobits per second
kbps	kilobits per second
L&EO	launch and early orbit
LOCC	Launch Operations Control Center
LOS	loss of signal
LZP	level zero processing
MC	Mission Coordinator
MECO	main engine cutoff
MOC	Mission Operations Center
MOM	Mission Operations Manager
MOPPS	
MOSA	Mission Operations Support Area
MRM	Mission Readiness Manager
MTDE	metric tracking data evaluation
NASA	National Aeronautics and Space Administration
Nascom	NASA Communications Division
NCC	Network Control Center

NOCC	JPL Network Operations Control Center
NOPE	JPL Network Operations Project Engineer
NORAD	North American Air Defense Command
ODB	operational data base
OPM	
OPN	
PACOR	Packet Processor
PDB	project data base
PI	Principal Investigator
PICS DB	
PML	Program Maintenance Library
PSAT	predicted site acquisition table
RF	radio frequency
RIFCA	
RT	real time
S/C	spacecraft
SCAMA	secure conferencing and monitoring arrangement
SECO	second engine cutoff
SOC	Science Operations Center
SOTA	Special Operations and Test Area
SSR	Solid State Recorder
STOL	system test and operations language
T&C	telemetry and command
TBD	to be determined
TCP	
TE	Test Engineer
TLAN	TPOCC Local Area Network

TOC	
TPOCC	Transportable Payload Operations Control Center
VC	virtual channel